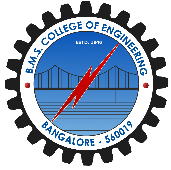
**B.M.S. COLLEGE OF ENGINEERING**

Basavanagudi, Bengaluru- 560019

# DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING



**LAB REPORT**

On

***Analysis and Design of Algorithms***

# (23CS4PCADA)

Submitted By:

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**1BM22CS355**

*In partial fulfilment of*

**BACHELOR OF ENGINEERING**

In

## COMPUTER SCIENCE AND ENGINEERING

2023-24

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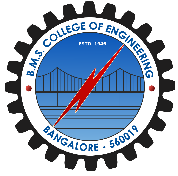
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### DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING



# *CERTIFICATE*

This is to certify that the Lab work entitled “Analysis and Design of Algorithms (23CS4PCADA)” conducted by **S Pranav Ranganath (1BM22CS355),** who is bonafide student at **B.M.S.College of Engineering**. It is in partial fulfilment for the award of **Bachelor of Engineering in Computer Science and Engineering** during the academic year 2023-24. The Lab report has been approved as it satisfies the academic requirements in respect of a Analysis and Design of Algorithms (23CS4PCADA) work prescribed for the said degree.

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Analysis and Design of Algorithms

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1. Write program to obtain the Topological ordering of vertices in a given digraph.

//C program to implement topological sort using DFS

#include <stdio.h>

int n, a[10][10], res[10], s[10], top = 0;

void dfs(int, int, int[][10]);

void dfs\_top(int, int[][10]);

int main()

{

printf("Enter the no. of nodes");

scanf("%d", &n);

int i, j;

for (i = 0; i < n; i++) {

for (j = 0; j < n; j++) {

scanf("%d", &a[i][j]);

}

}

dfs\_top(n, a);

printf("Solution: ");

for (i = n - 1; i >= 0; i--) {

printf("%d ", res[i]);

}

return 0;

}

void dfs\_top(int n, int a[][10]) {

int i;

for (i = 0; i < n; i++) {

s[i] = 0;

}

for (i = 0; i < n; i++) {

if (s[i] == 0) {

dfs(i, n, a);

}

}

}

void dfs(int j, int n, int a[][10]) {

s[j] = 1;

int i;

for (i = 0; i < n; i++) {

if (a[j][i] == 1 && s[i] == 0) {

dfs(i, n, a);

}

}

res[top++] = j;

}

OUTPUT:

Enter the no. of nodes6

0 0 1 1 0 0

0 0 0 1 1 0

0 0 0 1 0 1

0 0 0 0 0 1

0 0 0 0 0 1

0 0 0 0 0 0

Solution: 1 4 0 2 3 5

//C program to implement topological sort using source removal method

#include<stdio.h>

int a[10][10],n,t[10],indegree[10];

int stack[10],top=-1;

void computeIndegree(int,int [][10]);

void tps\_SourceRemoval(int,int [][10]);

int main(){

printf("Enter the no. of nodes: ");

scanf("%d",&n);

int i,j;

for(i=0;i<n;i++){

for(j=0;j<n;j++){

scanf("%d",&a[i][j]);

}

}

computeIndegree(n,a);

tps\_SourceRemoval(n,a);

printf("Solution:");

for(i=0;i<n;i++){

printf("%d ",t[i]);

}

return 0;

}

void computeIndegree(int n,int a[][10]){

int i,j,sum=0;

for(i=0;i<n;i++){

sum=0;

for(j=0;j<n;j++){

sum=sum+a[j][i];

}

indegree[i]=sum;

}

}

void tps\_SourceRemoval(int n,int a[][10]){

int i,j,v;

for(i=0;i<n;i++){

if(indegree[i]==0){

stack[++top]=i;

}

}

int k=0;

while(top!=

-1){

v=stack[top--];

t[k++]=v;

for(i=0;i<n;i++){

if(a[v][i]!=0){

indegree[i]=indegree[i]

-1;

if(indegree[i]==0){

stack[++top]=i;

}

}

}

}

}

OUTPUT:

Enter the no. of nodes: 5

0 0 1 0 0

1 0 0 1 0

0 0 0 0 1

0 0 1 0 1

0 0 0 0 0

Solution:1 3 0 2 4

1. Implement Johnson Trotter algorithm to generate permutations.

#include <stdio.h>

#include <stdlib.h>

void swap(int\* a, int\* b) {

int temp = \*a;

\*a = \*b;

\*b = temp;

}

void generatePermutations(int arr[], int start, int end) {

if (start == end) {

for (int i = 0; i <= end; i++) {

printf("%d ", arr[i]);

}

printf("\n");

} else {

for (int i = start; i <= end; i++) {

swap(&arr[start], &arr[i]);

generatePermutations(arr, start + 1, end);

swap(&arr[start], &arr[i]); // backtrack

}

}

}

int main() {

int n;

printf("Enter the number of elements: ");

scanf("%d", &n);

int\* arr = (int\*)malloc(n \* sizeof(int));

printf("Enter the elements: ");

for (int i = 0; i < n; i++) {

scanf("%d", &arr[i]);

}

generatePermutations(arr, 0, n - 1);

free(arr);

return 0;

}

OUTPUT:

Enter the number of elements: 4

Enter the elements: 1 2 3 4

1 2 3 4

1 2 4 3

1 3 2 4

1 3 4 2

1 4 3 2

1 4 2 3

2 1 3 4

2 1 4 3

2 3 1 4

2 3 4 1

2 4 3 1

2 4 1 3

3 2 1 4

3 2 4 1

3 1 2 4

3 1 4 2

3 4 1 2

3 4 2 1

4 2 3 1

4 2 1 3

4 3 2 1

4 3 1 2

4 1 3 2

4 1 2 3

3. Sort a given set of N integer elements using Merge Sort technique and compute its

time taken. Run the program for different values of N and record the time taken to

sort.

//C program to implement merge sort

#include <stdio.h>

#include<time.h>

int a[20],n;

void simple\_sort(int [],int,int,int);

void merge\_sort(int[],int,int);

int main()

{

int i;

clock\_t start, end;

double time\_taken;

printf("Enter the no. of elements:");

scanf("%d", &n);

printf("Enter the array elements:");

for (i = 0; i < n; i++) {

scanf("%d", &a[i]);

}

start = clock();

merge\_sort(a, 0, n - 1);

end = clock();

time\_taken = (double)(end - start) / CLOCKS\_PER\_SEC;

printf("Sorted array:");

for (i = 0; i < n; i++) {

printf("%d ", a[i]);

}

printf("\n");

printf("Time taken to sort: %f seconds\n", time\_taken);

return 0;

}

void merge\_sort(int a[],int low, int high){

if(low<high){

int mid=(low+high)/2;

merge\_sort(a,low,mid);

merge\_sort(a,mid+1,high);

simple\_sort(a,low,mid,high);

}

}

void simple\_sort(int a[],int low, int mid, int high){

int i=low,j=mid+1,k=low;

int c[n];

while(i<=mid && j<=high){

if(a[i]<a[j]){

c[k++]=a[i];

i++;

}else{

c[k++]=a[j];

j++;

}

}

while(i<=mid){

c[k++]=a[i];

i++;

}

while(j<=high){

c[k++]=a[j];

j++;

}

for(i=low;i<=high;i++){

a[i]=c[i];

}

}

OUTPUT:

Enter the no. of elements:10

Enter the array elements:8 96 32 75 62 78 63 48 56 100

Sorted array:8 32 48 56 62 63 75 78 96 100

Time taken to sort: 0.000002 seconds

4. Sort a given set of N integer elements using Quick Sort technique and compute its

time taken.

//C program to implement quick sort

#include <stdio.h>

#include<time.h>

int a[20],n;

int partition(int [],int, int);

void quick\_sort(int [],int,int);

void swap(int\*,int\*);

int main()

{

int i;

clock\_t start, end;

double time\_taken;

printf("Enter the no. of elements:");

scanf("%d", &n);

printf("Enter the array elements:");

for (i = 0; i < n; i++) {

scanf("%d", &a[i]);

}

start = clock();

quick\_sort(a, 0, n - 1);

end = clock();

time\_taken = (double)(end - start) / CLOCKS\_PER\_SEC;

printf("Sorted array:");

for (i = 0; i < n; i++) {

printf("%d ", a[i]);

}

printf("\n");

printf("Time taken to sort: %f seconds\n", time\_taken);

return 0;

}

void swap(int \*a,int \*b){

int temp=\*a;

\*a=\*b;

\*b=temp;

}

void quick\_sort(int a[],int low,int high){

if(low<high){

int mid=partition(a,low,high);

quick\_sort(a,low,mid-1);

quick\_sort(a,mid+1,high);

}

}

int partition(int a[],int low,int high){

int pivot=a[low];

int i=low;

int j=high+1;

while(i<=j){

do{

i=i+1;

}while(a[i]<pivot && i<=high);

do{

j=j-1;

}while(a[j]>pivot && j>=low);

if(i<j){

swap(&a[i],&a[j]);

}

}

swap(&a[j],&a[low]);

return j;

}

OUTPUT:

Enter the no. of elements:10

Enter the array elements:96 53 26 78 12 63 85 12 06 95

Sorted array:6 12 12 26 53 63 78 85 95 96

Time taken to sort: 0.000002 seconds

5. Sort a given set of N integer elements using Heap Sort technique and compute its

time taken.

//C program to implement heapify

#include<stdio.h>

int a[10],n;

void heapify(int[],int);

int main(){

printf("Enter the number of array elements:");

scanf("%d",&n);

int i;

printf("Enter array elements:");

for(i=0;i<n;i++){

scanf("%d",&a[i]);

}

heapify(a,n);

printf("Array elements:");

for(i=0;i<n;i++){

printf(" %d",a[i]);

}

return 0;

}

void heapify(int a[],int n){

int k;

for(k=1;k<n;k++){

int key=a[k];

int c=k;

int p=(c-1)/2;

while(c>0 && key>a[p]){

a[c]=a[p];

c=p;

p=(c-1)/2;

}

a[c]=key;

}

}

OUTPUT:

Enter the number of array elements:7

Enter array elements:50 25 30 75 100 45 80

Array elements: 100 75 80 25 50 30 45

6. Implement 0/1 Knapsack problem using dynamic programming.

//C program to implement knapsack problem in dynamic programming

#include <stdio.h>

int n,m,w[10],p[10],v[10][10];

void knapsack(int,int,int[],int[]);

int max(int,int);

int main()

{

int i,j;

printf("Enter the no. of items:");

scanf("%d",&n);

printf("Enter the capacity of knapsack:");

scanf("%d",&m);

printf("Enter weights:");

for(i=0;i<n;i++){

scanf("%d",&w[i]);

}

printf("Enter profits:");

for(i=0;i<n;i++){

scanf("%d",&p[i]);

}

knapsack(n,m,w,p);

printf("Optimal Solution:\n");

for(i=0;i<n;i++){

for(j=0;j<n;j++){

printf("%d ",v[i][j]);

}

printf("\n");

}

return 0;

}

void knapsack(int n, int m, int w[],int p[]){

int i,j;

for(i=0;i<n;i++){

for(j=0;j<m;j++){

if(i==0 || j==0){

v[i][j]=0;

}else if(w[i]>j){

v[i][j]=v[i-1][j];

}else{

v[i][j]=max(v[i-1][j],((v[i-1][j-w[i]])+p[i]));

}

}

}

}

int max(int a,int b){

if(a>b){

return a;

}else{

return b;

}

}

OUTPUT:

Enter the no. of items:4

Enter the capacity of knapsack:5

Enter weights:2 1 3 2

Enter profits:12 10 20 15

Optimal Solution:

0 0 0 0

0 10 10 10

0 10 10 20

0 10 15 25

7. Implement All Pair Shortest paths problem using Floyd’s algorithm.

//C program to implement floyd's algorithm

#include <stdio.h>

int a[10][10],D[10][10],n;

void floyd(int [][10],int);

int min(int,int);

int main()

{

printf("Enter the no. of vertices:");

scanf("%d",&n);

printf("Enter the cost adjacency matrix:\n");

int i,j;

for(i=0;i<n;i++){

for(j=0;j<n;j++){

scanf("%d",&a[i][j]);

}

}

floyd(a,n);

printf("Distance Matrix:\n");

for(i=0;i<n;i++){

for(j=0;j<n;j++){

printf("%d ",D[i][j]);

}

printf("\n");

}

return 0;

}

void floyd(int a[][10],int n){

int i,j,k;

for(i=0;i<n;i++){

for(j=0;j<n;j++){

D[i][j]=a[i][j];

}

}

for(k=0;k<n;k++){

for(i=0;i<n;i++){

for(j=0;j<n;j++){

D[i][j]=min(D[i][j],(D[i][k]+D[k][j]));

}

}

}

}

int min(int a,int b){

if(a<b){

return a;

}else{

return b;

}

}

OUTPUT:

Enter the no. of vertices:4

Enter the cost adjacency matrix:

0 99 3 99

2 0 99 99

99 6 0 1

7 99 99 0

Distance Matrix:

0 9 3 4

2 0 5 6

8 6 0 1

7 16 10 0

8. A. Find Minimum Cost Spanning Tree of a given undirected graph using Prim’s

algorithm.

//C program to implement prim's algorithm

#include <stdio.h>

int cost[10][10], n, t[10][2], sum;

void prims(int cost[10][10], int n);

int main() {

int i, j;

printf("Enter the number of vertices: ");

scanf("%d", &n);

printf("Enter the cost adjacency matrix:\n");

for (i = 0; i < n; i++) {

for (j = 0; j < n; j++) {

scanf("%d", &cost[i][j]);

}

}

prims(cost, n);

printf("Edges of the minimal spanning tree:\n");

for (i = 0; i < n - 1; i++) {

printf("(%d, %d) ", t[i][0], t[i][1]);

}

printf("\nSum of minimal spanning tree: %d\n", sum);

return 0;

}

void prims(int cost[10][10], int n) {

int i, j, u, v;

int min, source;

int p[10], d[10], s[10];

min = 999;

source = 0;

// Initialize arrays

for (i = 0; i < n; i++) {

d[i] = cost[source][i];

s[i] = 0;

p[i] = source;

}

s[source] = 1;

sum = 0;

int k = 0;

// Find MST

for (i = 0; i < n - 1; i++) {

min = 999;

u = -1;

// Find the vertex with minimum distance to the MST

for (j = 0; j < n; j++) {

if (s[j] == 0 && d[j] < min) {

min = d[j];

u = j;

}

}

if (u != -1) {

// Add edge to MST

t[k][0] = u;

t[k][1] = p[u];

k++;

sum += cost[u][p[u]];

s[u] = 1;

// Update distances

for (v = 0; v < n; v++) {

if (s[v] == 0 && cost[u][v] < d[v]) {

d[v] = cost[u][v];

p[v] = u;

}

}

}

}

}

OUTPUT:

Enter the number of vertices: 4

Enter the cost adjacency matrix:

0 1 5 2

1 0 99 99

5 99 0 3

2 99 3 0

Edges of the minimal spanning tree:

(1, 0) (3, 0) (2, 3)

Sum of minimal spanning tree: 6

B. Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal’s

algorithm.

//C program to implement Kruskal’s algorithm

#include <stdio.h>

int cost[10][10], n, t[10][2], sum;

void kruskal(int cost[10][10], int n);

int find(int parent[10], int i);

int main() {

int i, j;

printf("Enter the number of vertices: ");

scanf("%d", &n);

printf("Enter the cost adjacency matrix:\n");

for (i = 0; i < n; i++) {

for (j = 0; j < n; j++) {

scanf("%d", &cost[i][j]);

}

}

kruskal(cost, n);

printf("Edges of the minimal spanning tree:\n");

for (i = 0; i < n - 1; i++) {

printf("(%d, %d) ", t[i][0], t[i][1]);

}

printf("\nSum of minimal spanning tree: %d\n", sum);

return 0;

}

void kruskal(int cost[10][10], int n) {

int min, u, v, count, k;

int parent[10];

k = 0;

sum = 0;

// Initialize parent array for Union-Find

for (int i = 0; i < n; i++) {

parent[i] = i;

}

count = 0;

while (count < n - 1) {

min = 999;

u = -1;

v = -1;

// Find the minimum edge

for (int i = 0; i < n; i++) {

for (int j = 0; j < n; j++) {

if (find(parent, i) != find(parent, j) && cost[i][j] < min) {

min = cost[i][j];

u = i;

v = j;

}

}

}

// Perform Union operation

int root\_u = find(parent, u);

int root\_v = find(parent, v);

if (root\_u != root\_v) {

parent[root\_u] = root\_v;

t[k][0] = u;

t[k][1] = v;

sum += min;

k++;

count++;

}

}

}

int find(int parent[10], int i) {

while (parent[i] != i) {

i = parent[i];

}

return i;

}

OUTPUT:

Enter the number of vertices: 4

Enter the cost adjacency matrix:

0 1 5 2

1 0 99 99

5 99 0 3

2 99 3 0

Edges of the minimal spanning tree:

(1, 0) (3, 0) (2, 3)

Sum of minimal spanning tree: 6

9. Implement fractional Knapsack problem using Greedy technique.

#include <stdio.h>

void knapsack(int n, int p[], int w[], int W) {

int used[n];

for (int i = 0; i < n; ++i)

used[i] = 0;

int cur\_w = W;

float tot\_v = 0.0;

int i, maxi;

while (cur\_w > 0) {

maxi = -1;

for (i = 0; i < n; ++i)

if ((used[i] == 0) &&

((maxi == -1) || ((float)w[i]/p[i] > (float)w[maxi]/p[maxi])))

maxi = i;

used[maxi] = 1;

if (w[maxi] <= cur\_w) {

cur\_w -= w[maxi];

tot\_v += p[maxi];

printf("Added object %d (%d, %d) completely in the bag. Space left: %d.\n", maxi + 1,

w[maxi], p[maxi], cur\_w);

} else {

int taken = cur\_w;

cur\_w = 0;

tot\_v += (float)taken/p[maxi] \* p[maxi];

printf("Added %d%% (%d, %d) of object %d in the bag.\n", (int)((float)taken/w[maxi] \*

100), w[maxi], p[maxi], maxi + 1);

}

}

printf("Filled the bag with objects worth %.2f.\n", tot\_v);

}

int main() {

int n, W;

printf("Enter the number of objects: ");

scanf("%d", &n);

int p[n], w[n];

printf("Enter the profits of the objects: ");

for(int i = 0; i < n; i++){

scanf("%d", &p[i]);

}

printf("Enter the weights of the objects: ");

for(int i = 0; i < n; i++){

scanf("%d", &w[i]);

}

printf("Enter the maximum weight of the bag: ");

scanf("%d", &W);

knapsack(n, p, w, W);

return 0;

}

OUTPUT:

Enter the number of objects: 7

Enter the profits of the objects: 5 10 15 7 8 9 4

Enter the weights of the objects: 1 3 5 4 1 3 2

Enter the maximum weight of the bag: 15

Added object 4 (4, 7) completely in the bag. Space left: 11.

Added object 7 (2, 4) completely in the bag. Space left: 9.

Added object 3 (5, 15) completely in the bag. Space left: 4.

Added object 6 (3, 9) completely in the bag. Space left: 1.

Added 33% (3, 10) of object 2 in the bag.

Filled the bag with objects worth 36.00.

10.From a given vertex in a weighted connected graph, find shortest paths to other

vertices using Dijkstra’s algorithm.

// C program to implement Dijkstra's algorithm

#include <stdio.h>

int cost[10][10], n, result[10][2], weight[10];

void dijkstras(int [][10], int );

int main()

{

int i, j, s;

printf("Enter the number of vertices: ");

scanf("%d", &n);

printf("Enter the cost adjacency matrix:\n");

for (i = 0; i < n; i++) {

for (j = 0; j < n; j++) {

scanf("%d", &cost[i][j]);

}

}

printf("Enter the source vertex: ");

scanf("%d", &s);

dijkstras(cost, s);

printf("Path:\n");

for (i = 1; i < n; i++) {

printf("(%d, %d) with weight %d ", result[i][0], result[i][1], weight[result[i][1]]);

}

return 0;

}

void dijkstras(int cost[][10], int s){

int d[10], p[10], visited[10];

int i, j, min, u, v, k;

for(i = 0; i < 10; i++){

d[i] = 999;

visited[i] = 0;

p[i] = s;

}

d[s] = 0;

visited[s] = 1;

for(i = 0; i < n; i++){

min = 999;

u = 0;

for(j = 0; j < n; j++){

if(visited[j] == 0){

if(d[j] < min){

min = d[j];

u = j;

}

}

}

visited[u] = 1;

for(v = 0; v < n; v++){

if(visited[v] == 0 && (d[u] + cost[u][v] < d[v])){

d[v] = d[u] + cost[u][v];

p[v] = u;

}

}

}

for(i = 0; i < n; i++){

result[i][0] = p[i];

result[i][1] = i;

weight[i] = d[i];

}

}

OUTPUT:

Enter the number of vertices: 4

Enter the cost adjacency matrix:

0 1 5 2

1 0 99 99

5 99 0 3

2 99 3 0

Enter the source vertex: 0

Path:

(0, 1) with weight 1 (0, 2) with weight 5 (0, 3) with weight 2

11.Implement “N-Queens Problem” using Backtracking.

#include <stdio.h>

#include <stdbool.h>

bool place(int[], int);

void printSolution(int[], int);

void nQueens(int);

int main()

{

int n;

printf("Enter the number of queens: ");

scanf("%d",&n);

nQueens(n);

return 0;

}

void nQueens(int n){

int x[10];

int count=0;

int k=1;

while(k!=0){

x[k]=x[k]+1;

while(x[k]<=n && !place(x,k)){

x[k]=x[k]+1;

}

if(x[k]<=n){

if(k==n){

printSolution(x, n);

printf("Solution found\n");

count++;

}else{

k++;

x[k]=0;

}

}else{

k--;

}

}

printf("Total solutions: %d\n", count);

}

bool place(int x[10], int k){

int i;

for(i=1;i<k;i++){

if((x[i]==x[k])||(i-x[i]==k-x[k])||(i+x[i]==k+x[k])){

return false;

}

}

return true;

}

void printSolution(int x[10], int n){

int i;

for(i=1;i<=n;i++){

printf("%d ", x[i]);

}

printf("\n");

}

OUTPUT:

Enter the number of queens: 4

2 4 1 3

Solution found

3 1 4 2

Solution found

Total solutions: 2